Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

280.39
R31A
Cop. 2

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
JAN 30 1968
CURRENT SERIAL RECORDS

ARS 51-21
December 1967

Freight Shipment of California Strawberries in Mechanically Refrigerated Rail Cars

Test Shipments -- 1967

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

ACKNOWLEDGMENTS

Howard Hall, Chairman, Research Committee, California Strawberry Advisory Board, and Manager of Salinas Strawberries, Inc., was instrumental in initiating the test series and providing fruit and cars for this study.

Additional thanks go to the following organizations and companies for assistance in arranging tests and supplying materials:

California Strawberry Advisory Board, Watsonville, Calif.
California Grape & Tree Fruit League, San Francisco, Calif.
Trans-Fresh Corp., Salinas, Calif.
Driscoll Associates, Watsonville, Calif.

CONTENTS

Page

Summary 3

Background 3

Methods 4

Results 5

    Temperatures in transit 5

    Gas concentration 6

    Cutting and bruising 6

    Decay 7

Conclusions 7

Literature cited 10

Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

FREIGHT SHIPMENT OF CALIFORNIA STRAWBERRIES IN MECHANICALLY REFRIGERATED RAIL CARS, TEST SHIPMENTS--1967

By

C. Max Harris, physiologist; Frank M. Porter, plant pathologist;
and John M. Harvey, investigations leader;
Market Quality Research Division,
Agricultural Research Service

SUMMARY

Mechanically refrigerated rail cars with mixed loads of strawberries and lettuce were shipped via freight service from California to New York. Berry temperatures in the center of the pallets averaged about 7° F. above the thermostat settings (34° or 36°) of the rail cars. No differences in temperature were found between pallets with no covering and those enclosed in a polyethylene bag.

The berries averaged 7.5 percent bruising and cutting injury in three rail test shipments. Similar amounts of mechanical injury were noted in air shipments to the same destination. Polystyrene foam cushioning material placed under strawberry pallets did not significantly reduce bruising and cutting injury when compared with pallets with no cushions.

Decay of berries in open pallets averaged 4.6 percent on arrival, 13.5 percent after 1 additional day, and 47.7 percent after 2 days at 60° F. Rail car atmospheres contained about 2 percent O_2 and had no CO_2 initially and averaged 6 percent O_2 and 4 percent CO_2 at destination. Decay was negligible on arrival in berries enclosed in 5 mil polyethylene bags that were either flushed with a gas mixture of 10 percent CO_2 and 5 percent O_2 or provided with a 1-pound block of dry ice. However, on arrival these berries had undesirable off-flavors, which persisted for at least 4 days.

BACKGROUND

Strawberries from the Salinas-Watsonville area are usually shipped by air or railway express to eastern markets, or transported to closer markets by truck. Railway express shipments have recently declined in volume partly because of scheduling problems and shortages of equipment. During peak periods of berry production, the demand for transportation exceeds the supply of express cars and space available on other modes of transportation. The lack of transportation thus causes losses to shippers.

The need for an additional shipping method that would alleviate this problem prompted a series of tests in which mixed loads of strawberries and lettuce were shipped in mechanically refrigerated rail cars via freight service.

METHODS

Five mechanically refrigerated rail cars were shipped via freight service from Salinas, Calif., to New York, N.Y., during the summer of 1967. Each car had 10 pallets of strawberries in the doorway area with the remaining space filled with lettuce. Five pallets of berries were placed along each side of the car. The pallets were then braced in both crosswise and lengthwise directions with 1- by 4-inch lumber. Load dividers separated the two commodities.

Each pallet load of berries consisted of 72 or 84 trays (stacked 12 or 14 layers high), which were held together at the top by a frame made of 1- by 4-inch lumber. Two nylon straps encircled the pallet load of berries, holding the frame, berry trays, and pallet together.

Two strips of polystyrene foam 1/ (1-7/8 inch thick, 4 inches wide, 40 inches long) were used as a cushion under each pallet in the first three test shipments. The fourth and fifth test shipments compared pallets having no cushioning material with pallets having 1-7/8-inch, 1-inch, and 1/2-inch polystyrene foam cushion strips.

All berries were precooled before loading into the cars. Most lots were held overnight in the precooling room. The average temperature of the fruit at loading was 39° F.

Air temperatures in the car and berry temperatures in the center of the pallets were measured with Ryan recording thermometers.

Thermostats on the rail cars were set at 36° F. (2 tests), or 34° (3 tests).

All cars had a modified atmosphere for lettuce of 2-percent oxygen (O_2), 2-percent carbon monoxide (CO), and 96-percent nitrogen (N_2) introduced before shipment.

Some individual pallets were enclosed in a sealed 5-mil polyethylene bag to increase CO_2 concentration around the berries. The CO_2 increase was provided by either purging with a gas mixture that produced an initial 10-percent CO_2 and 5-percent O_2 level, or by placing a 1-pound block of dry ice inside the enclosed pallet. The dry ice was wrapped in paper and placed in an empty berry flat. Another empty flat was placed below the ice to prevent freezing of adjacent fruit.

1/ Density 2.2 pounds per cubic foot.

Gas sampling tubes were inserted into the bagged pallets and into the interior of the rail cars. The concentrations of CO_2 and O_2 were measured with an Orsat-type analyzer in the rail cars and inside the bagged pallets on arrival in New York.

Test trays of comparable berries were placed in the top, middle, and bottom layers of the pallets and recovered upon arrival in New York. These berries were examined for bruising and cutting on arrival and for decay on arrival and after 1 and 2 days at 60° F.

RESULTS

Temperatures in Transit

The transit period was about 6 days for all the rail shipments sent via freight service. Berry temperatures in the center of the pallets averaged 42.5° F. and air temperatures averaged 38.5°, when a thermostat setting of 36° was used (fig. 1). At a 34° thermostat setting, the average berry temperature was 41.5° and the air, 35.5°.

No difference in temperature was found between pallets with no covering and those enclosed in a polyethylene bag.

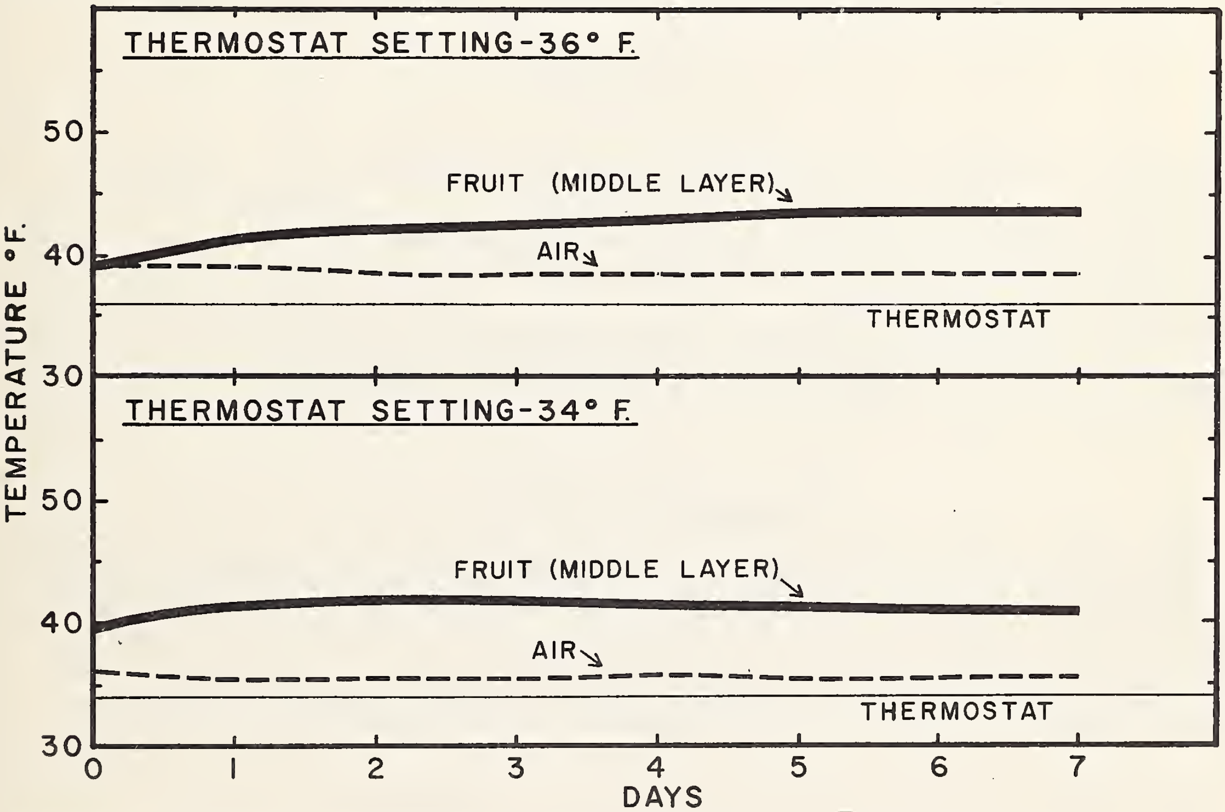

Figure 1.--Average temperatures in the middle layers of pallet loads of California strawberries shipped at indicated thermostat settings to New York, N.Y.

Gas Concentrations

Carbon dioxide concentrations in the rail cars on arrival in New York ranged from 1.8 to 5.2 percent and averaged about 4 percent (table 1). Oxygen concentrations on arrival ranged from 2.1 to 14.7 percent in the cars and averaged about 6 percent. No off-flavors were noted in berries exposed to this range of CO_2 and O_2 concentration.

Atmospheres in the polyethylene enclosed pallets ranged from 0.3 to 10.3 percent O_2 and from 8.9 to 28.2 percent CO_2 (table 1). All berries enclosed in the polyethylene bags had off-flavors on arrival, which persisted for at least 4 days.

Table 1.--Carbon dioxide and oxygen concentrations in rail cars and pallets of strawberries, enclosed in polyethylene, upon arrival in New York

Test No.	Atmosphere in rail car		Atmosphere in polyethylene-enclosed pallets			
			Dry ice added		Initial atmosphere 10 percent CO_2--5 percent O_2	
	CO_2	O_2	CO_2	O_2	CO_2	O_2
	Percent	Percent	Percent	Percent	Percent	Percent
1	1.8	14.7	--	--	--	--
2	5.2	4.0	28.2	0.6	27.6	0.3
3	--	--	12.3	5.7	8.9	10.3
4	4.2	2.1	--	--	--	--
5	4.7	3.0	--	--	--	--
Average	4.0	6.0	20.2	3.1	18.2	5.3

Cutting and Bruising

The test berries in the first three rail shipments were rated for cuts and bruises by using the severity scale shown in table 2. These three rail shipments were compared with two air shipments sent to the same destination in June 1967 (table 2). Cutting and bruising averaged 13.2 and 19.4 percent in the berries sent by air, and ranged from 5.4 to 10.0 percent in berries shipped by rail.

Cutting and bruising in rail shipments 4 and 5 cannot be directly compared with cutting and bruising in rail shipments 1, 2, and 3 because the test berries in these two cars were rated more severely for this defect. The more severe rating was made in order to detect any small difference between cushioning treatments. These two rail shipments compared pallets having no cushioning material with pallets having 1-7/8-inch, 1-inch, and 1/2-inch polystyrene foam cushion pads. The percentage cutting and bruising found in the various cushioning treatments is shown in table 3. Differences in the percentage of mechanical injury in pallets with various cushions and pallets with no cushions were not statistically significant.

Decay

Average decay of test berries in open pallets from all five test shipments was 4.6 percent on arrival and 13.5 percent and 47.7 percent after 1 and 2 days, respectively, at 60° F. A direct comparison of severity of decay between rail shipments and air shipments is not available; however, the decay percentages above are similar to those previously observed in air shipments (2, 3).[2]

Decay was greatly reduced in berries that were exposed to a high concentration of CO_2 during transit (table 4). This advantage in decay control was nullified, however, by off-flavors, which were present on arrival and persisted for 4 days or more.

CONCLUSIONS

Rail cars sent via freight service occasionally receive severe longitudinal shocks during switching of cars and elsewhere in transit. Because of these shocks, it is important that strawberry pallets in rail cars have ample bracing to prevent shifting of the load. The importance of bracing was demonstrated in a test shipment of strawberries sent via freight service in 1964.[3] This test was unsatisfactory because inadequate bracing resulted in extensive crushing of the berries in the shifted areas of the load. The five rail cars used in the present tests were well braced and arrived in good order with no shifting of the load.

The addition of polystyrene foam cushioning under the pallets did not significantly reduce cutting and bruising injury of the berries. Any slight reduction in mechanical injury which might be obtained by using these cushions would not justify the effort and expense required to install them on the pallets.

---

[2] Underscored figures in parentheses refer to Literature Cited at end of report.

[3] Couey, H. M., Harris, C. M., and Porter, F. M. 1964. (Unpublished data).

Table 2.--Cutting and bruising of California strawberries shipped by air or rail to New York, summer 1967

Test	Cuts and bruises [1]
	Percent
Air 1	13.2
Air 2	19.4
Rail 1 [2]	7.0
Rail 2 [2]	5.4
Rail 3 [2]	10.0

[1] Generally indicates a cut of about 5/8-inch or more in length and 1/8-inch or more in depth or pressure bruises totaling 5/8-inch or more in diameter.

[2] Two strips of polystyrene foam (1-7/8-inch thick) used as a cushion under all pallets.

Table 3.--Cutting and bruising of California strawberries shipped, on pallets with various thicknesses of polystyrene foam cushioning, to New York, summer 1967

Thickness of cushioning	Cuts and bruises [1]	
	Rail test 4	Rail test 5
	Percent	Percent
No cushion	21.6	17.2
1/2-inch cushion	22.1	10.6
1-inch cushion	18.3	16.2
1-7/8-inch cushion	13.6	14.2

[1] Generally indicates a cut of about 1/2-inch or more in length and 1/16-inch or more in depth or pressure bruises totaling 1/2-inch or more in diameter. Differences between treatments were not significant by analysis of variance.

Table 4.--Decay in California strawberries in relation to atmosphere modification

Type of pallet and atmosphere [1]	Decay		
	On arrival	After 1 day at 60° F.	After 2 days at 60° F.
	Percent	Percent	Percent
Open pallet [2] (2 percent O_2 and 0.0 percent CO_2 initially)	6.8	24.2	62.3
Polyethylene-enclosed [2] pallet with dry ice added	[3] .3	2.8	6.1
Polyethylene-enclosed [2] pallet with modified atmosphere (10 percent CO_2 and 5 percent O_2 initially)	[3] .7	2.7	7.0

1/ Average of tests 2 and 3.

2/ See table 1 for O_2 and CO_2 concentrations upon arrival in New York.

3/ Berries from these pallets on arrival had off-flavors which persisted for at least 4 days.

Previous experiments have shown that CO_2 at proper concentrations is effective in retarding decay development in strawberries (1, 4, 5, 6, 7). The CO_2 concentration that will control decay without injuring the berries varies with the length of time the berries are exposed to the gas. Strawberries can tolerate relatively high CO_2 concentrations during short times in air transit (2, 3), but not during longer times in rail freight-transit.

The polyethylene bags used in the rail tests were tightly sealed allowing no leakage of gases into or out of the pallet load of berries. Most of the O_2 in the bags was consumed by respiration of the berries. The resultant low O_2 and high CO_2 atmospheres reduced decay development to a very low level, but caused persistent off-flavors to develop in the berries.

This problem might be solved by the addition of small holes in the polyethylene bag which would allow a limited gas exchange between the atmosphere inside the bag with the atmosphere outside the bag. More work is needed to determine the proper leakage rate to provide the proper atmosphere for strawberries shipped in polyethylene bags.

The results of these tests indicate that strawberries when loaded properly can be shipped in mechanically refrigerated rail cars via freight service without excessive losses due to bruising or decay.

LITERATURE CITED

(1) Brooks, Charles, Miller, E. V., Bratley, C. O., and others.
1932. Effect of solid and gaseous carbon dioxide upon transit diseases of certain fruits and vegetables. U.S. Dept. Agr. Tech. Bul. 318, 59 pp., illus.

(2) Harvey, John M., Couey, H. Melvin, Harris, C. Max and Porter, Frank M.
1966. Air transport of California strawberries: factors affecting market quality in summer shipments--1965. U.S. Dept. Agr. Mktg. Res. Rpt. 751, 12 pp., illus.

(3) Harvey, John M., Couey, H. Melvin, Harris, C. Max, and Porter, Frank M.
1966. Air transport of California strawberries: factors affecting market quality in spring shipments--1966. U.S. Dept. Agr. Mktg. Res. Rpt. 774, 9 pp., illus.

(4) Landon, R. H., Vogele, A. C., and Alderman, W. H.
1937. The carbon dioxide treatment of raspberries and strawberries. Amer. Soc. Hort. Sci. Proc. 35: 188-192.

(5) Smith, W. H.
1957. The application of precooling and carbon dioxide treatment to the marketing of strawberries and raspberries. Sci. Hort. 12(1): 147-153.

(6) Smith, W. Hugh
1958. The handling, precooling, transport and storage of strawberries and raspberries. Dept. Sci. and Ind. Res., Food Investigations. Misc. Paper No. 10/58, 14 pp., illus.

(7) Winter, J. D., Landon, R. H., and Alderman, W. H.
1939. Use of CO_2 to retard the development of decay in strawberries and raspberries. Amer. Soc. Hort. Sci. Proc. 37: 583-588.

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Hyattsville, Maryland 20782

Official Business

Postage and Fees Paid
U. S. Department of Agriculture